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Vostok (Antarctica) ice-core time-scale from datings of different origins

Salamatin A., Tsyganova E., Lipenkov V., Petit J.
Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

Three different approaches to ice-core age dating are employed to develop a depth-age relationship at Vostok, Antarctica: (1) correlating the ice-core isotope record to the geophysical metronome (Milankovich surface temperature cycles) inferred from the borehole temperature profile, (2) importing a known chronology from another (Devils Hole, Nevada, USA) paleoclimatic signal, and (3) direct ice-sheet flow modeling. Inverse Monte Carlo sampling is used to constrain the accumulation-rate reconstruction and ice-flow simulations in order to find the best-fit glaciological time-scale matched with the two other chronologies. The general uncertainty of the different age estimates varies from 2 to 6 kyr on average and reaches 6-15 kyr at maximum. Whatever the causes of this discrepancy might be, they are thought to be of different origins, and the age errors are assumed statistically independent. Thus, the average time-scale for the Vostok ice core down to 3350 m depth is deduced consistent with all three dating procedures within the standard deviation limits of ± 3.6kyr, and its accuracy is estimated as 2.2 kyr on average. The constrained ice-sheet flow model allows, at least theoretically, extrapolation of the ice age-depth curve further to the boundary with the accreted lake ice where (at 3530 m depth) the glacier-ice age may reach ~2000 kyr.